

# IN THE SPECIFICATION

Please amend the original Specification with the Substitution Specification enclosed herewith. A mark up version and a clean version are listed appended, where those cancelled are deleted by a cross line and those amended are indicated by an underline. The Substitute Specification was necessitated due to the some grammatical, and idiomatic errors associated with the Specification as filed, and kindly noted by the Examiner. Furthermore, the screwing angles  $\theta 1$  to  $\theta 4$  are changed as helix angles 01 to 04 so as to match the general uses in mechanics. Furthermore, the order of the threads, helical angles and sections are rearranged to have an order which makes the reader can easily understand the specification and claims. The Substitute Specification is being inserted for purpose of clarity and ease of understanding by the Examiner. From the mark-up version appended, it is appreciated that no new matter has been incorporated therein.

## **"MARK-UP" COPY OF THE AMENDED SPECIFICATION**

### **SCREW WITH A PLURALITY OF HELIX ANGLES AND MOLD DEVICE FOR FORMING THE SAME**

#### **Field of the invention**

The present invention relates to screws, and particular to a screw with a plurality of helix angles and a mold device for forming the screw.

#### **Background of the invention**

The prior art screw has a thread with unique orientation. With reference to Fig. 12, an operation for about screwing a prior art screw is illustrated. It is illustrated that the screw is screwed into a work piece with a constant orientation. This results in that ~~It results that~~ the screw is tightly clamped by the work piece so that the friction force is larger and thus the screwing work is difficult. When the screw is longer, the difficulty in locking the screw is enhanced.

#### **Summary of the invention**

Accordingly, the primary object of the present invention is to provide a screw with a plurality of helix angles which comprises a first section having a first thread with a first helix angle, at least one third section having a third ~~second~~ thread with a third ~~second~~ screwing angle; and a fifth section having a first thread with a first helix angle. The third ~~second~~ helix angle is equal or not equal to the first helix angle. Moreover, screw further comprises a second section connected between the first section and the third section; the second section having a second ~~fourth~~ thread with a second ~~fourth~~ helix angle; a fourth section connected

between the third section and the fifth section; and the fourth section having a fourth ~~third~~ thread with a fourth ~~third~~ helix angle. A mold device for forming the screw is also included.

The various objects and advantages of the present invention will be more readily understood from the following detailed description when read in conjunction with the appended drawing.

### **Brief Description of the Drawings**

Fig. 1 is a plan schematic view of the screw of the present invention.

Fig. 2 is a schematic view showing that the first helix angle is greater ~~larger~~ than the second helix angle according to the present invention.

Fig. 3 is a schematic view showing that the first helix angle is smaller than the second helix angle according to the present invention.

Fig. 4 is a cross section view showing that a screw is screwed into a work piece according to the present invention.

Fig. 5 is a schematic view showing the curves in the twisting test according to the present invention.

Fig. 6 is a schematic perspective view of the mold device of the present invention.

Fig. 7 is a plan schematic view of the mold device of the present invention.

Fig. 8 is a schematic perspective view of a two mold case of the present invention.

Fig. 9 is a schematic view showing that the orientation of the first sloped recess is greater ~~larger~~ than that of the second sloped recess according to the present invention.

Fig. 10 is a schematic view showing that the orientation of the first sloped recess is smaller than that of the second sloped recess according to

the present invention.

Fig. 11 is a schematic view showing the curves about the twisting test of the prior art.

Fig. 12 is a schematic cross view about the operation of the prior art screw.

### Detailed Description of the Invention

In order that those skilled in the art can further understand the present invention, a description will be described in the following in details. However, these descriptions and the appended drawings are only used to cause those skilled in the art to understand the objects, features, and characteristics of the present invention, but not to be used to confine the scope and spirit of the present invention defined in the appended claims.

The present invention will be described here.

With reference to Figs. 1 to 3, the screw 1 of the present invention includes a first section 51 having a first thread 11 with a first helix angle  $\theta_1$ , and at least one third section 53 having a third ~~second~~ thread 13 ~~12~~ with a ~~second~~ third helix angle  $\theta_3$   ~~$\theta_2$~~  and a fifth section 55 having a fifth thread 15 with the first helix angle  $\theta_1$  which is ~~the~~ identical to that in the first section 1. Indeed, the fifth thread 15 is identical the first thread 11, namely, they have the same thread pitch and helix angle. The third ~~second~~ helix angle  $\theta_3$   ~~$\theta_2$~~  is not equal to the first helix angle  $\theta_1$ . Preferably, the third ~~second~~ helix angle  $\theta_3$   ~~$\theta_2$~~  is greater ~~larger~~ than the first helix angle  $\theta_1$  or the third ~~second~~ helix angle  $\theta_3$   ~~$\theta_2$~~  is smaller than the first helix angle  $\theta_1$ .

A second section 52 is connected between the first section 51 and the third section 53. The second section 52 has a second ~~fourth~~ thread 12 ~~14~~ with a second ~~fourth~~ helix angle  $\theta_2$   ~~$\theta_4$~~ . A fourth section 54 is connected between the third section 53 and the fifth section 55. The fourth section

54 has a fourth ~~third~~ thread 14 ~~13~~ with a fourth ~~third~~ helix angle 04 ~~03~~. The fourth ~~third~~ helix angle 04 ~~03~~ is smaller than the first helix angle 01 and / or the second ~~fourth~~ helix angle 02 ~~04~~ is smaller than the first helix angle 01.

The thread pitch of the third ~~second~~ thread 13 ~~12~~ is 150 to 170 % of the thread pitch of the first thread 11, and the thread pitch of the fourth ~~third~~ thread 14 ~~13~~ and / or the second ~~fourth~~ ~~helix angle~~ 04 ~~03~~ is 67 to 75 % of that of the first thread 11.

The thread pitch of the third ~~second~~ thread 13 ~~12~~ is 30 to 50 % of the first thread 11; and the thread pitch of the fourth ~~third~~ thread 14 ~~13~~ and / or second ~~fourth~~ thread 12 ~~14~~ is 125 to 135 % of that of the first thread 11.

The fourth ~~third~~ helix angle 04 ~~03~~ is equal or unequal to the second ~~fourth~~ helix angle 02 ~~04~~.

Referring to Figs. 4, the operation of the present invention will be described here. In screwing the screw 1, the fifth section 55 firstly moves into the work piece, and the fifth thread 15 identical to the first thread 11 serves to cut into the work piece, where the indication A in Fig. 4 is a cut screw channel. When the fourth section 54 having the fourth ~~third~~ thread 14 ~~13~~ enters into the work piece, the channel A will be enlarged at one side so as to be form with an enlarged portion A1 due to the fourth ~~third~~ helix angle 04 ~~03~~ of the third thread 13 fourth ~~third~~ thread 14 ~~13~~ different from the first helix angle 01 as the dashed line shown in Fig. 4. When the screw 1 enters into the work piece continuously, due to the third ~~second~~ helix angle 03 ~~02~~ of the third ~~second~~ thread 13 ~~12~~, the channel A is further enlarged at another side so as to be formed with form another enlarged portion A2. Next, the second ~~fourth~~ thread 12 ~~14~~ enters into the work piece. The channel is further enlarged to have a proper width as the indication A2 shown in Fig. 4. Thereby, when the first section 51 of the screw with the first thread 11 further enters into the

work piece, since the channel is enlarged, the screw can enter into the work piece with less friction. This is especially beneficial for long screws.

The test result of the present invention with the prior art screw will be described herein.

The test object: CH1B wood screw.

Specification: Major diameter / depth of the thread / pitch : 4.0 / 50 / 1.8

Number of test object: 10, the average value is calculated.

Referring to Figs. 5, the test result is illustrated. It is illustrated the larger twisting force of the screw of the present invention is at a point of about 2.0 to 2.5 cm with an average twisting force of 34.2 kg/cm. Then, after the portion of the screw after that point, the twisting force is normal. This means that when a long screw is used, less power is necessary. The required twisting force will not increase due to the increment of length of the screw.

Referring to Figs. 11, it is illustrated that the average value for the prior art screw is 46.1 /kg/cm. The longer the screw, the larger the twisting force. Thus it is difficult to lock a long screw.

Thereby, it is known from above test result, as comparing with a screw of 5 cm, the present invention can save a force of 25 % than the prior art. The longer the screw, the greater ~~larger~~ the force to be saved.

With reference to Figs. 6 to 10, the mold for forming the screw 1 of the present invention will be described herein. A mold 2 for forming a screw with a plurality of screw angle comprises a first mold which has a plurality of recesses 61 (see Fig. 8) approximately arranged in parallel. Each recess 61 includes two first sloped recesses 21 for forming the first thread 11 with a first helix angle  $\theta_1$  and a second sloped recess 22 for forming the second thread 12 with a second helix angle  $\theta_2$ . The second

sloped recess 22 is connected between the two first sloped recesses 21. The orientation of the second sloped recess 22 is different from that of the first sloped recesses 21.

With reference to Figs. 7, 9, and 10, the first mold further includes a third sloped recess 23 connected between one of the first sloped recess 21 and the second sloped recess 22 so as to be as an input end and a fourth sloped trench 24 connected between the other one of the first sloped recess 21 and the second sloped recess 22 so as to be as an output end.

The orientations of the third sloped recess 23 and the fourth sloped trench 24 may be identical or different. Preferably, when the orientation of the first sloped recess 21 is set as a horizontal direction, the absolute value of the slope of the third sloped recess 23 is identical to or different from the slope of the fourth sloped trench 24.

In the present invention, the slope of the orientation of the second sloped recess 22 is larger than that of the first sloped recess 21, as shown in Fig. 9 or the slope of the orientation of the second sloped recess 22 is smaller than that of the first sloped recess 21, as shown in Fig. 10.

Moreover, the mold 2 further comprises a second mold 201. The second mold is symmetrical to the first mold, as shown in Fig. 8.

The present invention is thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the present invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

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#### **Summary of the invention**

Accordingly, the primary object of the present invention is to provide a screw with a plurality of helix angles which comprises a first section having a first thread with a first helix angle, at least one third section having a third thread with a third screwing angle; and a fifth section having a first thread with a first helix angle. The third helix angle is equal or not equal to the first helix angle. Moreover, screw further comprises a second section connected between the first section and the third section; the second section having a second thread with a second helix angle; a fourth section connected between the third section and the



fifth section; and the fourth section having a fourth thread with a fourth helix angle. A mold device for forming the screw is also included.

The various objects and advantages of the present invention will be more readily understood from the following detailed description when read in conjunction with the appended drawing.

### **Brief Description of the Drawings**

Fig. 1 is a plan schematic view of the screw of the present invention.

Fig. 2 is a schematic view showing that the first helix angle is greater than the second helix angle according to the present invention.

Fig. 3 is a schematic view showing that the first helix angle is smaller than the second helix angle according to the present invention.

Fig. 4 is a cross section view showing that a screw is screwed into a work piece according to the present invention.

Fig. 5 is a schematic view showing the curves in the twisting test according to the present invention.

Fig. 6 is a schematic perspective view of the mold device of the present invention.

Fig. 7 is a plan schematic view of the mold device of the present invention.

Fig. 8 is a schematic perspective view of a two mold case of the present invention.

Fig. 9 is a schematic view showing that the orientation of the first sloped recess is greater than that of the second sloped recess according to the present invention.

Fig. 10 is a schematic view showing that the orientation of the first sloped recess is smaller than that of the second sloped recess according to the present invention.

Fig. 11 is a schematic view showing the curves about the twisting test of the prior art.

Fig. 12 is a schematic cross view about the operation of the prior art screw.

### **Detailed Description of the Invention**

In order that those skilled in the art can further understand the present invention, a description will be described in the following in details. However, these descriptions and the appended drawings are only used to cause those skilled in the art to understand the objects, features, and characteristics of the present invention, but not to be used to confine the scope and spirit of the present invention defined in the appended claims.

The present invention will be described here.

With reference to Figs. 1 to 3, the screw 1 of the present invention includes a first section 51 having a first thread 11 with a first helix angle  $\theta_1$ , and at least one third section 53 having a third thread 13 with a third helix angle  $\theta_3$  and a fifth section 55 having a fifth thread 15 with the first helix angle  $\theta_1$  which is identical to that in the first section 1. Indeed, the fifth thread 15 is identical the first thread 11, namely, they have the same thread pitch and helix angle. The third helix angle  $\theta_3$  is not equal to the first helix angle  $\theta_1$ . Preferably, the third helix angle  $\theta_3$  is greater than the first helix angle  $\theta_1$  or the third helix angle  $\theta_3$  is smaller than the first helix angle  $\theta_1$ .

A second section 52 is connected between the first section 51 and the third section 53. The second section 52 has a second thread 12 with a second helix angle  $\theta_2$ . A fourth section 54 is connected between the third section 53 and the fifth section 55. The fourth section 54 has a fourth thread 14 with a fourth helix angle  $\theta_4$ . The fourth helix angle  $\theta_4$  is smaller than the first helix angle  $\theta_1$  and / or the second helix angle  $\theta_2$  is

smaller than the first helix angle  $\theta_1$ .

The thread pitch of the third thread 13 is 150 to 170 % of the thread pitch of the first thread 11, and the thread pitch of the fourth thread 14 and / or the second thread 12 is 67 to 75 % of that of the first thread 11.

The thread pitch of the third thread 13 is 30 to 50 % of the first thread 11; and the thread pitch of the fourth thread 14 and / or second thread 12 is 125 to 135 % of that of the first thread 11.

The fourth helix angle  $\theta_4$  is equal or unequal to the second helix angle  $\theta_2$ .

Referring to Figs. 4, the operation of the present invention will be described here. In screwing the screw 1, the fifth section 55 firstly moves into the work piece, and the fifth thread 15 identical to the first thread 11 serves to cut into the work piece, where the indication A in Fig. 4 is a cut screw channel. When the fourth section 54 having the fourth thread 14 enters into the work piece, the channel A will be enlarged at one side so as to be formed with an enlarged portion A1 due to the fourth helix angle  $\theta_4$  of the third thread 13 fourth thread 14 different from the first helix angle  $\theta_1$  as the dashed line shown in Fig. 4. When the screw 1 enters into the work piece continuously, due to the third helix angle  $\theta_3$  of the third thread 13, the channel A is further enlarged at another side so as to be formed with another enlarged portion A2. Next, the second thread 12 enters into the work piece. The channel is further enlarged to have a proper width as the indication A2 shown in Fig. 4. Thereby, when the first section 51 of the screw with the first thread 11 further enters into the work piece, since the channel is enlarged, the screw can enter into the work piece with less friction. This is especially beneficial for long screws.

The test result of the present invention with the prior art screw will be described herein.

The test object: CH18 wood screw.

Specification: Major diameter / depth of the thread / pitch : 4.0 / 50 /

1.8

Number of test object: 10, the average value is calculated.

Referring to Figs. 5, the test result is illustrated. It is illustrated the larger twisting force of the screw of the present invention is at a point of about 2.0 to 2.5 cm with an average twisting force of 34.2 kg/cm. Then, after the portion of the screw after that point, the twisting force is normal. This means that when a long screw is used, less power is necessary. The required twisting force will not increase due to the increment of length of the screw.

Referring to Figs. 11, it is illustrated that the average value for the prior art screw is 46.1 /kg/cm. The longer the screw, the larger the twisting force. Thus it is difficult to lock a long screw.

Thereby, it is known from above test result, as comparing with a screw of 5 cm, the present invention can save a force of 25 % than the prior art. The longer the screw, the greater the force to be saved.

With reference to Figs. 6 to 10, the mold for forming the screw 1 of the present invention will be described herein. A mold 2 for forming a screw with a plurality of screw angle comprises a first mold which has a plurality of recesses 61 (see Fig. 8) approximately arranged in parallel. Each recess 61 includes two first sloped recesses 21 for forming the first thread 11 with a first helix angle  $\theta_1$  and a second sloped recess 22 for forming the second thread 12 with a second helix angle  $\theta_2$ . The second sloped recess 22 is connected between the two first sloped recesses 21. The orientation of the second sloped recess 22 is different from that of the first sloped recesses 21.

With reference to Figs. 7, 9, and 10, the first mold further includes a third sloped recess 23 connected between one of the first sloped recess 21

and the second sloped recess 22 so as to be as an input end and a fourth sloped trench 24 connected between the other one of the first sloped recess 21 and the second sloped recess 22 so as to be as an output end.

The orientations of the third sloped recess 23 and the fourth sloped trench 24 may be identical or different. Preferably, when the orientation first sloped recess 21 is set as a horizontal direction, the absolute value of the slope of the third sloped recess 23 is identical to or different from the slope of the fourth sloped trench 24.

In the present invention, the slope of the orientation of the second sloped recess 22 is larger than that of the first sloped recess 21, as shown in Fig. 9 or the slope of the orientation of the second sloped recess 22 is smaller than that of the first sloped recess 21, as shown in Fig. 10.

Moreover, the mold 2 further comprises a second mold 201. The second mold is symmetrical to the first mold, as shown in Fig. 8.

The present invention is thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the present invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.